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Vendor Selected Report for Computer-Assisted Data Acceptance of Raster Identification Data

19 June 1992

Prepared for
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Joint
Computer-aided Acquisition
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VENDOR SELCTION REPORT FOR COMPUTER-ASSISTED DATA ACCEPTANCE OF RASTER IDENTIFICATION DATA

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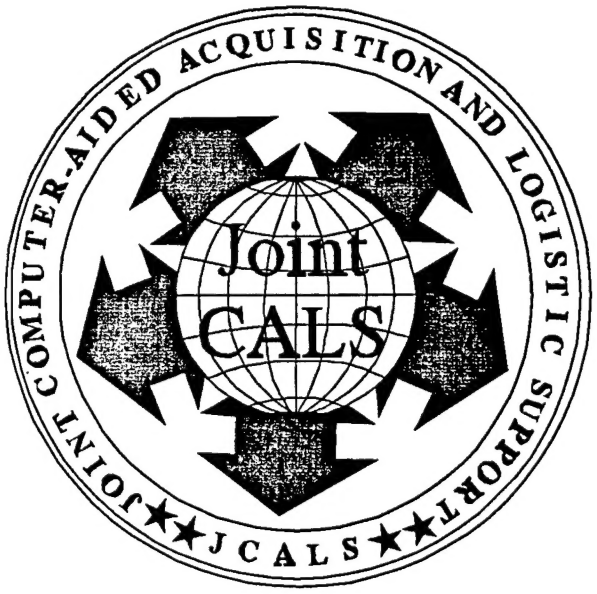

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1.0 INTRODUCTION

1.1 Background

Army PM JCALS, under the direction of the CALS Test Network Office (CTNO), has developed Computer-Assisted Data Acceptance (CADA) procedures for automating the acceptance of CALS raster, Type I, data. The objective of these procedures is to reduce the labor requirements of the currently used manual quality assurance (QA) procedures. Effective implementation of the CADA procedures depends on the use of reliable image quality analysis and identification recogniton techniques and tools. The QA procedure requires evaluating the quality of the image data as well as the quality and accuracy of key identification data (ID) within the body of the image field. The identification data such as DRAWING NO., SIZE, REV., SHEET NO., etc. are keyed into the header field as ASCII characters. This ID is then used to generate the index for locating the drawings, hence it must be correct. However, due to the fact that the ID is not always accurate, errors can be made during the preparation of the header data. It is therefore necessary to ensure that the header ASCII ID is the same as the ID within the image area of the drawing. This is done visually by actually looking at the image ID and the header ID. Obviously, manually viewing each image is not only labor intensive, but also time consuming. Because of the above mentioned facts alternative methods were investigated to automate the verification of the accuracy of the identification data within the CALS delivered engineering drawing image and associated header areas.

A technology search within industry, government and academia was initiated to investigate techniques that would ease the labor intensive process described above. Pattern recognition techniques, optical character recognition (OCR) techniques and Artificial Intelligence (AI) techniques were reviewed. The OCR technology was tested from a number of vendors, the results proved that the recognition of hand printed data could not be successfully done at the present stage of OCR technology development. Further, intelligent character recogniton (ICR) techniques employing neural network technology were also analyzed. These results were much more acceptable, especially in regards to the quality of data to be expected if the CALS standards/specifications were followed. The above mentioned findings are documented in a reference report entitled, "Test Report: Phase III Computer-Assisted Data Acceptance" dated 26 May, 1992.

The first step in the CADA identification recognition process is to look for the title block contained in the raster image of the engineering drawing. This entails locating the title block image area and all of the text fields (and their data) within that area, and then extracting the key ID data from the text fields for character recognition. This process of searching for the title block area and the extraction of the appropriate ID text data is call preprocessing. The testing results pointed out the need to include preprocessing of the key ID image data within the CADA software and then deliver it to the neural network engine for recognition processing. A number of the neural network products were evaluated; this report identifies those commercial-off-the-shelf (COTS) products that have been recommended for use in the CADA of CALS raster data. Additional information related to the leasing costs and availability are also included.

1.2 Purpose

This report identifies neural network vendors and their ICR products suitable for possible licensing by the Government when using CADA software tools to accept CALS raster data.

1.3 Scope

This report provides a brief background on the need for automating the recognition and acceptance of identification data within the image and header fields of raster data defined by MIL-STD-1840 and MIL-R-28002. The approach for identifying ICR vendors, analyzing their technology, and evaluating their capabilities and costs have also been included. Further, criteria necessary for the consideration of licensing vendor products by the Government are also given.

1.4 Approach

Thirteen OCR and ICR vendor products were reviewed for various levels of detail. The OCR products did not perform in the recognition of "hand printed" characters. Additional testing was performed on four selected neural network ICR products. The detailed test results were documented in the reference report entitled, "Test Report: Phase III Computer-Assisted Data Acceptance" dated 26 May, 1992.

The approach taken in this report is to evaluate the vendors products in the following four areas: platform dependency, technical merits, support capability, and license cost and considerations. The platforms considered for CADA were PCs and SUN Workstations due to the popularity of these two platforms in the current usage of engineering drawing systems. The technical merits of the products were based on the results of the tests which were conducted under the above mentioned CADA activities. Vendors' support capabilities available for the integration phase and operational testing phase were also considered in the selection. The terms and conditions of the candidate vendors licensing agreements and the costs will also be considered.

Detailed vendor selection considerations and capabilities are explained in Section 2.0. Section 3.0 presents information for other vendors evaluated to date.

2.0 SELECTED VENDOR INFORMATION

2.1 Selection Considerations

The Computer-Assisted Data Acceptance (CADA) procedures developed at the Army CALS Technology Center, under the auspices of the CALS Test Network Office (CTNO), focus on the acceptance of production (Level III) engineering drawing data. The detailed test results were documented in the reference report mentioned above and dated 26 May, 1992. The test results provides the basic information for the selection. In addition to the test results, the vendor selection is also based on the following criteria.

1. *Platform Dependency.* The platforms that are considered for the CADA performance tests are the PCs and the SUN Workstations. The choice of the two platforms are based on the current availability of the platforms in the existing engineering drawing management systems (EDMICS and the governments DeskTop IV DoD wide procurement). Products that need specialized hardware or add-on boards are not considered.

The following table 2-1 lists candidate vendors tested and documented in the Test Report for the two desired platforms.

VENDOR'S	PC	SUN
OCR/NTI	X	
MCC		X
Nestor		X
VisionShape	X	

Table 2-1

(Note: OCR/NTI is planning to have their product ported to SUN Workstation. Further, Nestor has already ported a version to the PC and MCC is planning to have a version run on PC).

2. *Technical Merits.* The technical merits of the vendors' products are based on the results of the tests which were conducted under the above mentioned CADA activities. The technical merits of the tested products can be summarized by two major factors:

- recognition capability based on field recognition percentage,
- recognition capability based on character recognition percentage.

3. *Support Capability.* Vendors' support capabilities for the integration phase and fielded production phase were evaluated and considered for the selection.

4. *License Cost and Consideration.* The terms and conditions of the candidate vendors' licenses and the product costs are considered and the results are shown in the following sections.

2.2 Vendors' Capabilities

Based on the technical merits as indicated in the Test Report, OCR/NTI has the best recognition results for PC and MCC has the best recognition results for SUN Workstation. In addition to these two companies, Nestor has provided reasonable recognition capability. Table 2-2 provides a test summary of the three companies selected for testing followed by a description of each of the companies capabilities and product characteristics.

	Nestor	NTI	MCC
General			
1) flexibility to for integration into CADA system;	M	M	M
2) speed;	M	H	L
3) software quality and stability	H	M	M
4) Application Program Interface (API)	M	L	L
Preprocessing Test			
1) box finding capability;	L	H	H
2) text finding capability	H	H	H
3) key field correlation;	L	H	H
4) line and box removal	H	H	H
Character Recognition Test			
1) character segmentation accuracy;	M	H	M
2) character recognition accuracy;	M	H	H
3) neural network trainability for new character styles	not tested	not tested	not tested
Postprocessing Test Criteria			
1) heuristic capability	not tested	not tested	not tested
2) validation capability	not tested	not tested	not tested
Key: H:High M:Medium L:Low			

Table 2-2

2.2.1 OCR Systems/Non-Linear Technology (NTI)

OCR Systems, Inc. is the developer of ReadRight OCR products. They have also introduced a version of this software with hand-printed character recognition capabilities, which was developed in conjunction with Nonlinear Technologies(NTI), Inc. of Greenbelt, MD. Their product currently runs on PCs under Windows 3.0.

NTI's product performs reasonably well and at an acceptable speed without additional hardware boards to accelerate the PC. It has the capability of recognizing hand written characters of alphabetic, numeric or mixed type. Its capability of distinguishing mixed alphabetic and numeric characters has a better recognition accuracy than any other software tested. NTI uses line tracing techniques to locate the boxes in the title block area in order to perform the preprocessing function.

2.2.2 Microelectronics and Computer Technology Corporation (MCC)

MCC used a supervised learning algorithm developed in their laboratory environment to recognize and segment the hand-printed alpha and numeric characters that overlapped. Their recognition engine was especially good at recognizing hand scripted characters. They do not, however, have the capability to accomodate preprocessing. Therefore, the front-end text image extraction was developed by Act Laboratory, Altamonte Springs, FL.

The Act Laboratory's preprocessing algorithm used corner matching technology. However, the software is still in a development stage, hence it is not very stable nor can all the boxes in a title block area be accurately identified. Therefore, the potential recognition capability for MCC's software is not fully shown in these test results although they were second in recognizing characters, behind the NTI product.

2.2.3 Nestor, Providence, RI.

Nestor used an enhanced version of its NestorReader™ version 1.0 to participate in the CADA identification recognition test. NestorReader accepts binary images in both TIFF and PCX formats, segments and recognizes both constrained and unconstrained touching characters. Further, it has the capability to do its own image compression and decompression. The version of NestorReader tested for this task runs on the Sun Sparcstation. A fully parallel implementation of the NestorReader is also available on the INMOS Transputer™ (TRAM) - a small micro-processor with dedicated memory. Each TRAM can accept a full compressed image, a zone, or a character.

Nestor added pure text extraction to the front-end of the NestorReader software for the preprocessing CADA tests so that the identified candidate character string image could be recognized by the NestorReader. Nestor has specially trained neural networks for different types of characters such as; machine-printed, hand-written, alphabetic, and numerics. Character recognition capability was improved by adding additional segmentation algorithms and further neural network training of the hand-printed characters on the engineering drawings.

2.3 Support Capabilities

Vendors' support capabilities available for the integration phase and fielded production phase were evaluated and considered for selection. Both products of OCR/NTI and Nestor are distributed and supported through a nationwide network of computer resellers. MCC's product is in a laboratory environment and is now ready for a commercial company (such as DEC and/or Texas Instruments) to sell as a product. Table 2-3 shows the support capabilities of the three companies that have passed the technical evaluation criteria.

VENDOR'S	SUPPORT CAPABILITY
OCR/NTI	High
MCC	Low
Nestor	High

Table 2-3

(Note: The reason for MCC's low grade support capability is due to the fact that their tool is not yet commercially released. The situation may improve once the product is released).

2.4 Licensing Cost and Considerations

The following list shows licensing agreements that were requested from the prospective vendors:

a. A copy of the standard license agreement for use of their product to develop, reproduce and distribute executable programs.

b. A statement specifically indicating what their product deliverable(s) include(s) and exclude(s): source code, object files, object libraries, executable programs, executable libraries, documentation, sample source code, utilities, sample test data, hardware, media, development support and update support. The price of each deliverable should also be indicated.

c. A statement specifically indicating what part of their product can or cannot be distributed with executable programs.

d. A statement describing on what platforms(s) executable programs can be developed with their product. For each platform all hardware and software, including the operating system, required to run executable programs must be specified.

e. A statement of the cost(s) for a license to distribute executable programs developed with their product for each of the following scenarios:

1) Royalty-free distribution
2) Per-copy distribution
3) Per-user distribution
4) Per-site distribution
5) Per-site cost at a maximum of 2 field sites.

The vendors response was to send their standard schedule which is based on per-copy and therefore not user or site dependent. The MCC costs include preprocessing so their cost is much higher. Table 2-4 depicts the vendors license costs to the government.

VENDOR'S	PER-COPY	PER-10 COPIES	PER-20 COPIES	PER-50 COPIES	ABOVE 100 COPIES
OCR/NTI	$2,500	$15,000	$25,000	$30,000	$500 (each)
Nestor-SUN	$6,000	$42,000	$84,000	$210,000	$3,000 (each)
Nestor-PC	$1,500	$10,500	$21,000	$52,500	$825 (each)
MCC-SUN	$12,000	$12,000	$12,000	$10,000	$8,000 (each)

Table 2-4

3.0 OTHER VENDORS EVALUATED

The following is the preliminary list of available vendors initially selected as the potential candidates to perform the identification recognition test:

AT&T,
OCR systems/Non-Linear Technology (NTI),
VisionShape,
Symbus,
Calera,
Ektron,
OCRON, and
HNC,
Nestor,
MCC,
CAERE,
Datacap,
NYNEX,
Recognitto.

Some vendors were eliminated in the early preliminary test conducted in the previous phase of CADA (see *Technical Report, Testing Techniques for Data Acceptance Procedures*, 12 July 1991). These vendors were eliminated due to one or more of the following reasons:

- did not have ICR recognition technology that is necessary to provide required recognition accuracy to satisfy our needs;
- could not have their product ready to meet our test schedule;
- did not have preprocessing capability to utilize their ICR technology;

- would not participate due to lack of short term incentives; or
- needed specialized hardware.

(NOTE : At a later date, if the reason for elimination is no longer true, it may be worthwhile to review and reconsider these companies. For example, if the preprocessing capability can be developed independent of any vendor [or obtained from a vendor with unlimited distribution rights within the Government agencies], then those vendors that were eliminated before due to the lack of preprocessing capabilities can be reconsidered, if they have good recognition engines. Also, if special hardware boards needed to accelerate the recognition speed becomes available at a more reasonable cost, then the various vendors should be reconsidered.)

4.0 RECOMMENDATIONS

The following recommendations are made based on the overall assessment of the ICR technology as well as the preprocessing and postprocessing needed for the ID recognition.

1. It is recommended that a commercial-off-the-shelf (COTS) recognition product be used without the preprocessing and postprocessing add-on capabilities for the CADA ID task. The CADA ID test results which were documented in the reference report entitled, "Test Report: Phase III Computer-Assisted Data Acceptance" dated 26 May, 1992, included the results of preprocessing, recognition and postprocessing. It is not clear which product has the best recognition engine, provided that the preprocessing parts were equalized for all vendors. It is understood, however, that for each recognition package, some software interface customization may be needed.

2. It is recommended that the preprocessing and postprocessing capabilities be developed by the Government so that the recognition engine can be more easily replaced from one vendor's product to that of another vendor's. The reason is due to the fast progress in the ICR technology area which will allow technology insertion into the CADA test procedure in the future. It is also imperative that during the CADA test product life-cycle to keep track of future products that can be used for CADA in the future. To allow the recognition engine to be replaced in the design will make the continuous improvements possible in this fast growing technology area.

3. It is recommended that the OCR/NTI's product be used as the recognition engine for the CADA ID test on the PC or PC compatible platforms.

4. It is recommended that the MCC and Nestor products be used as the recognition engines for the CADA ID test on the SUN Workstations platform.

5. It is recommended that if any vendor fails to provide adequate support during the integration or the operational testing phase, that vendor's product be replaced.

6. It is recommended that when new products for the recognition engines become available, further tests must be conducted to verify the suitability of those products for the CADA task.

5.0 SUMMARY

Technical merits for the vendors' products were based on the test results conducted under Computer-Assisted Data Acceptance (CADA) procedures developed at the Army CTC - the CALS Technology Center, under the auspices of the CALS Test Network Office (CTNO), focus on the acceptance of production (Level III) engineering drawing data. Other factors considered for the vendor selection includes: platform, support capability, and licensing cost and agreements.

It is concluded that preprocessing capabilities will be developed by the Government so that the recognition engine can be more easily replaced from one vendor's product to that of another vendor's. Three companies were selected for consideration regarding their products to be used in the follow-on integration phase and operational testing phase. Due to the fast progress in the ICR technology area, it is important to allow technology insertion into the CADA test procedure. Therefore, new products will be monitored in addition to the current products on hand.

6.0 LIST OF ACRONYMS

ASCII	American Standard Code for Information Interchange
CADA	Computer-Assisted Data Acceptance
CALS	Computer-aided Acquisition and Logistic Support
COTS	Commercial-Off-The-Shelf
CTC	CALS Technology Center
CTNO	CALS Test Network Office
ICR	Intelligent Character Recognition
ID	Identification Data
OCR	Optical Character Recognition

7.0 REFERENCE DOCUMENTS

Test Report: Phase III Computer-Assisted Data Acceptance. May 26, 1992.

MIL-STD-1840A, *Military Standard, Automated Interchange of Technical Information*, 20, December 1988

MIL-R-28002A, *Raster Graphics Representation in Binary Format, Requirement for*, 30, November 1990